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FISH DISCHARGE RESIDENCY STUDY, PICKERING NGS B POSTOPERATIONAL STUDY, 1987

Report No 88-267-K

L.P. King and J.K. Kwik
Biological Research Section
Chemical Research Department

ABSTRACT

A fish discharge residency study was conducted in the Pickering NGS A discharge from March through July and in the Pickering NGS B discharge from February through July. According to diver observations carp, white sucker, smallmouth bass and yellow perch were commonly present in the Pickering NGS A discharge while alewife, freshwater drum, gizzard shad, rock bass, walleye, white bass, and white perch were present intermittently. In the Pickering NGS B discharge, carp, freshwater drum, smallmouth bass, walleye and white sucker were common while alewife, gizzard shad, rock bass, white bass and white perch were present intermittently. The attraction of game fish such as smallmouth bass, walleye and white bass to the discharges increases their vulnerability to anglers. Smallmouth bass spawned in the Pickering NGS B discharge with nests and fry first observed on June 3. Spawning of smallmouth bass in the Pickering NGS B discharge may result in an increase in the local population. Gizzard shad were not present in very high numbers in either discharge. No large influxes of spawning walleye or walleye spawning activity were observed at either of the discharges. Gill net catches at the periphery of the discharges suggests that there were no nocturnal influxes of spawning walleye either.

job	file	date	report no.
34-159-492	837.321 PIC	November 11, 1988	88-267-K

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EXECUTIVE SUMMARY

FISH DISCHARGE RESIDENCY STUDY, PICKERING NGS B POSTOPERATIONAL STUDY, 1987

L.P. King and J.K. Kwik
Biological Research Section
Chemical Research Department

A fish residency study was conducted in the Pickering NGS A and B discharges from February through July of 1987. The study was requested by the Environmental Studies and Assessment Department of the Design and Development-Generation Division of Ontario Hydro on behalf of Pickering Engineering Department. It is part of the second year of a three-year Pickering NGS B postoperational aquatic study initiated in 1986.

Diver observations indicated that carp, white sucker, smallmouth bass and yellow perch were present in the Pickering NGS A discharge over most of the study period. Alewife, freshwater drum, gizzard shad, rock bass, walleye, white bass, and white perch were present intermittently.

In the Pickering NGS B discharge, carp, freshwater drum, smallmouth bass, walleye and white sucker were present for most of the study period while alewife, gizzard shad, rock bass, white bass and white perch were present intermittently.

The attraction of game fish such as smallmouth bass, walleye, and white bass to the discharges increases their vulnerability to anglers.

Smallmouth bass spawned in the Pickering NGS B discharge with nests and fry first observed on June 3. The nests were located in protected areas where the water was calm. This would prevent offshore displacement and entrainment of larvae through the condenser cooling water system. Thus the spawning of smallmouth bass in the Pickering NGS B discharge may result in an increase in the local population.

Gizzard shad were not present in very high numbers in either of the discharges. However, with the limited number of winter observations, the low numbers observed do not necessarily preclude massive impingement events.

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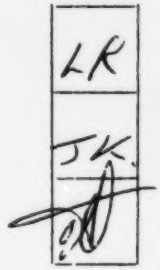
The numbers of walleye in the discharges were low and no large influxes of spawning walleye or spawning activity were observed. The absence of walleye from gill net catches at the periphery of the discharges suggests that there were no nocturnal influxes of spawning walleye. However, the position of the walleye in the discharge currents suggested that they were attracted by the strong currents.



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FISH DISCHARGE RESIDENCY STUDY, PICKERING NGS B POSTOPERATIONAL STUDY, 1987

1.0 INTRODUCTION

A fish discharge residency study was conducted in the Pickering NGS B discharge from February through July, 1987, and in the Pickering NGS A discharge from March through July, 1987. The study was requested by the Environmental Studies and Assessments Department of the Design and Development - Generation Division on behalf of the Pickering Engineering Department. It is part of the second year of a three-year Pickering NGS B postoperational aquatic study initiated in 1986. Fish discharge residency studies will be continued in the winter of 1987-1988.

Pickering NGS B is a nuclear station consisting of four CANDU powered 540 MW units (Units 5-8) located on the north shore of Lake Ontario at Pickering, Ontario. Pickering NGS A, which also consists of four CANDU powered 540 MW units (Units 1-4) is situated on the west side of Pickering NGS B.

The two stations share a common surface condenser cooling water intake. Pickering NGS B discharges its cooling water to the east of the development while Pickering NGS A discharges to the west. The calculated temperature increase across the condenser with two pumps per unit and four units operating is estimated at 9.2°C for Pickering NGS B and 9.7°C for Pickering NGS A (RMEP-IR-07211-1). Pickering NGS B uses 33.4 m^3 of cooling water per unit per second and Pickering NGS A uses 30.8 m^3 per unit per second.

At a workshop on the postoperational environmental monitoring program for Pickering NGS B conducted in 1985, several hypotheses concerning the effects of the thermal discharges on fish populations were formulated (Greig et al 1986). This study is concerned with the hypotheses postulated for smallmouth bass, gizzard shad and walleye.

In the case of smallmouth bass, the hypothesis was that favorable habitat characteristics and elevated temperatures would attract them to the discharge. Spawning in the thermal discharge would be advanced resulting in increased growth periods and in turn increased survival of young-of-the-year. Surviving larvae would be recruited to the local smallmouth bass population resulting in an increase in the local population.

The hypothesis on gizzard shad is that the "discharge of heated water from the Pickering B NGS, in combination with plume entrainment, will lead to impingement of significant numbers of gizzard shad and will interfere with station operation" (Greig et al 1986). Since shad prefer warm water it was assumed that they would be attracted to the thermal plumes resulting in increased numbers in the discharges. These increased densities would result in increased impingement when recirculation of discharged water occurs. Massive impingement during storm events could result in disruption of station operation.

The hypothesis on walleye is that the "Pickering thermal discharge and the physical presence of the Pickering station will decrease walleye stocks" (Greig et al 1986). It was postulated that the rapid currents would attract walleye to the discharge. The fast currents and elevated temperatures in the discharge channel provides optimal conditions for walleye spawning. However, the elevated temperatures in the discharge results in hatch advancement and increased egg mortality. In addition, walleye larval survival may be reduced due to low food supply, predation and entrainment.

The objectives of the present study were to determine whether gizzard shad or other species reside in the plume during the winter, to assess the abundances of walleye and smallmouth bass in the discharges and determine whether they spawn in the discharges.

May to November juvenile and adult fish surveys have been conducted around Pickering NGS B by beach seine, trap net and gill net since 1979 (Ontario Hydro Research Division Report Nos 84-135-K, 83-435-K, 84-341-K, 87-149-K and 87-194-K); however, winter fishing efforts are lacking. The discharge fish residency study will add to our knowledge of the winter fish communities around the Pickering NGS A and B discharges.

2.0 METHODS

Observations on fish resident within the discharge channel were obtained by SCUBA equipped divers. Dives were scheduled from January through July. However, poor visibility in the discharges precluded diving in January of 1987 and limited diving frequency in the remaining winter months.

Divers swam along the walls and bottom of the discharge channels. The discharges were divided into zones (Figures 1 and 2) and observations were recorded for each zone. Dives were made during the daytime and lasted approximately 20 minutes per discharge channel side (40 minutes per discharge).

Fish observed singly or in small groups were counted while numbers of fish observed in larger aggregations were estimated. Temperature was recorded at the start of the dives. Observations were also made on substrate and water current direction.

Mean daily intake and outfall temperatures were obtained from Radioactivity Management and Environmental Protection Department of Technical and Training Services Division of Ontario Hydro.

To determine whether there was movement of spawning walleye into the discharges in the night, gill nets were set at the periphery of the discharges: to the west of the Pickering NGS A discharge and to the east of the Pickering NGS B discharge. Gill netting was conducted approximately weekly from late March through late April.

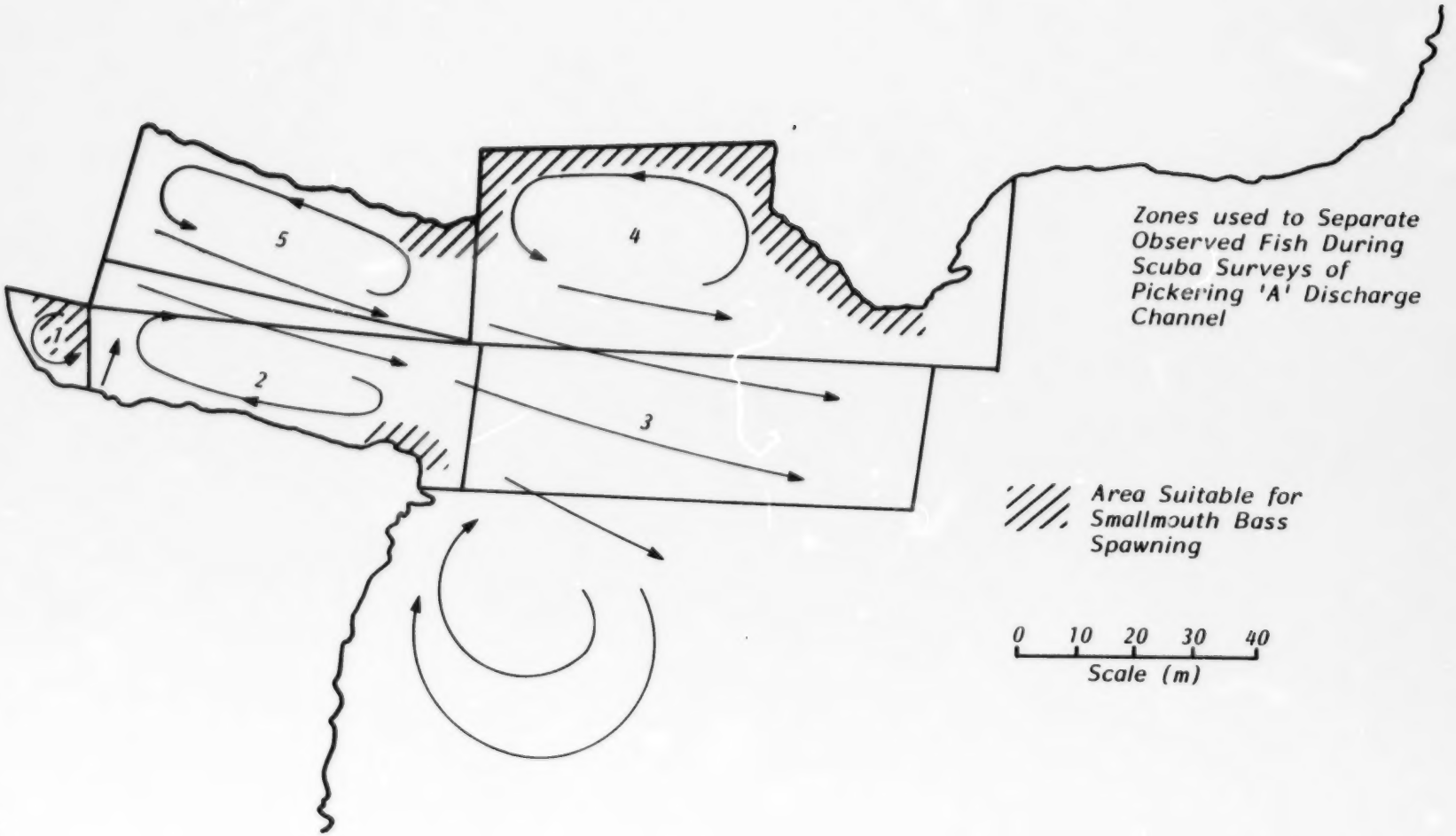

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FIGURE 1

PICKERING 'A' DISCHARGE CHANNEL
CURRENT PATTERNS AND FISH
OBSERVATION ZONES

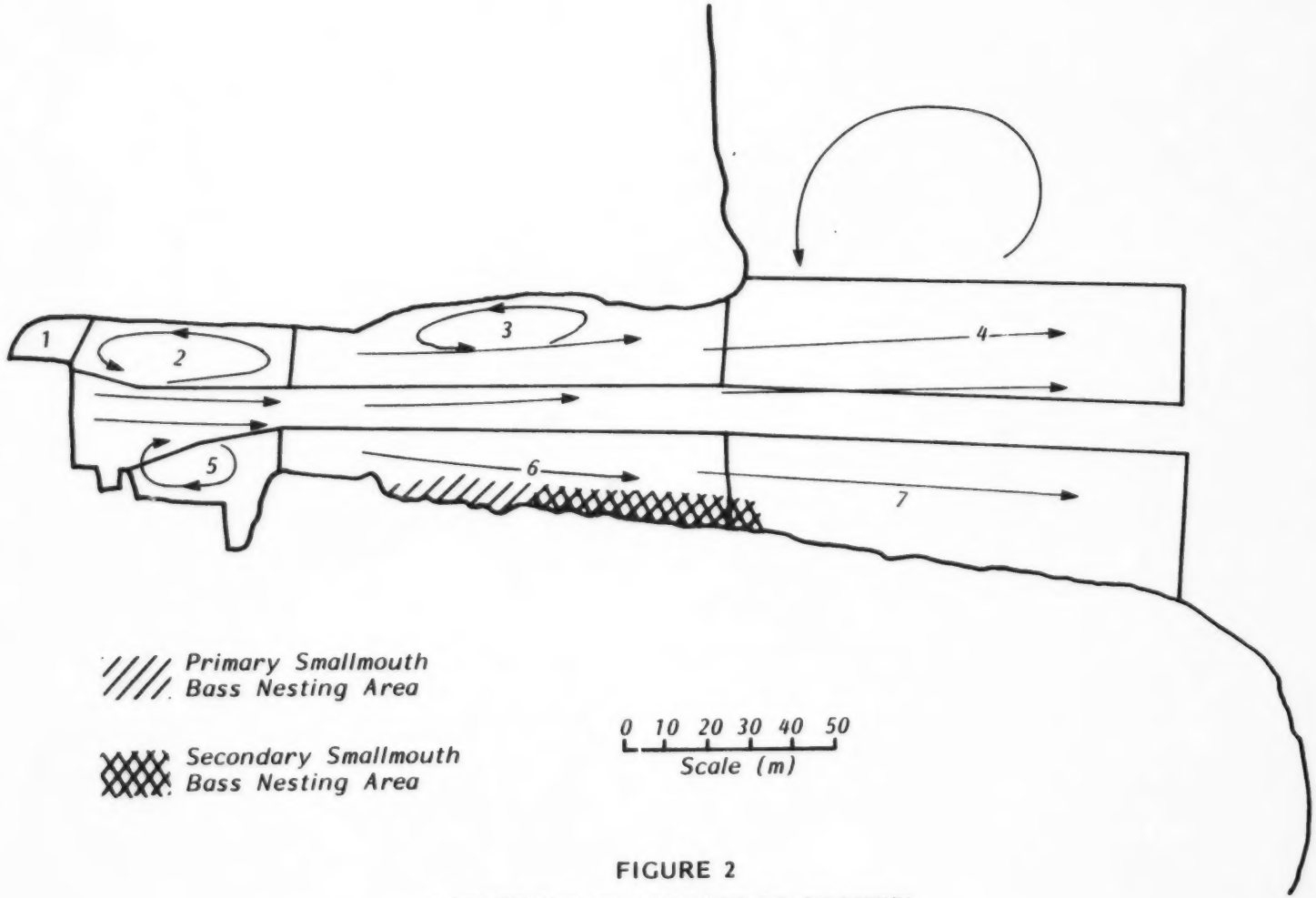


FIGURE 2

PICKERING 'B' DISCHARGE CHANNEL
CURRENT PATTERNS AND
FISH OBSERVATION ZONES

177643-RD

Gill nets consisted of eight 15 m-panels with mesh size increasing in 1.3 cm increments from 3.8 cm to 12.7 cm. The nets were set along the bottom, perpendicular to shore, for 24-hour periods.

In addition, from April 30 to June 1, smallmouth bass were captured underwater by divers and tagged with Floy tags. Sightings of tagged fish were recorded during subsequent residency dives. On days when tagging was conducted, only partial surveys were carried out. Areas surveyed on these days are noted in Appendices 1 and 2.

3.0 RESULTS AND DISCUSSION

3.1 Operation Record

For most of the January through July study period Pickering NGS A had two units (units 3 and 4) operating. The exceptions were short periods in January and June when only unit 3 was operational, and from mid-July to the end of July when only unit 4 was operating. At Pickering NGS B three or four units were operational for most of the study period. The exception was a short period in April when only two units were operational. All four units were operational in January and February. Unit 8 was out of service for most of March and April. Unit 6 was out of service for a short period in April while unit 5 was out from early May through mid-June.

3.2 Water Temperature

Condenser cooling water inlet and outlet water temperatures for Pickering NGS A and B are presented in Figures 3 and 4. Inlet temperatures at both stations indicated a gradual warming of the water starting in late March with a more rapid warming after mid-May. Upwellings characterized by sharp drops in the temperature occurred several times in July.

Mean daily ΔT's between inlet and outlet temperatures ranged from 3 to 11.5°C at Pickering NGS A. Generally, the temperature increases across the station were higher in February and March, and lower in July. Mean monthly ΔT in February and March was 10.3°C and in July it was 6.9°C. At Pickering NGS B mean daily ΔT's ranged from 4.3°C to 11.2°C. At this station the ΔT's were highest in April and June and lowest in May and June. Mean monthly ΔT's were 10.0°C and 10.1°C in April and June, respectively, and 7.8°C and 7.9°C in May and June.

On most days inlet temperatures were slightly higher than that measured 1 m below the water surface at a 5.5 m depth station 2.0 km east of the Pickering NGS B discharge (Geotechnical and Hydraulic Engineering Location THB32). This suggests that some recirculation of condenser cooling water occurred on most days.

3.3 Substrate

Pickering NGS A Discharge Channel

Along the sides in zones 1, 2 and 5 in the Pickering NGS A discharge channel the substrate consisted mainly of cobble with some boulders (Figure 5). In the centre of the channel, the bottom was composed of cobble and boulder embedded in clay. Zone 3 consisted of sand and gravel except at its western limit where a clay bank was found. The substrate in zone 4 consisted of sand with boulder along the side at the outer end of the zone. Attached algae was observed on the cobble and boulder along the shoreline from early spring onward.

FIGURE 3

INLET AND OUTLET TEMPERATURES (C)

PICKERING NGS A – 1987

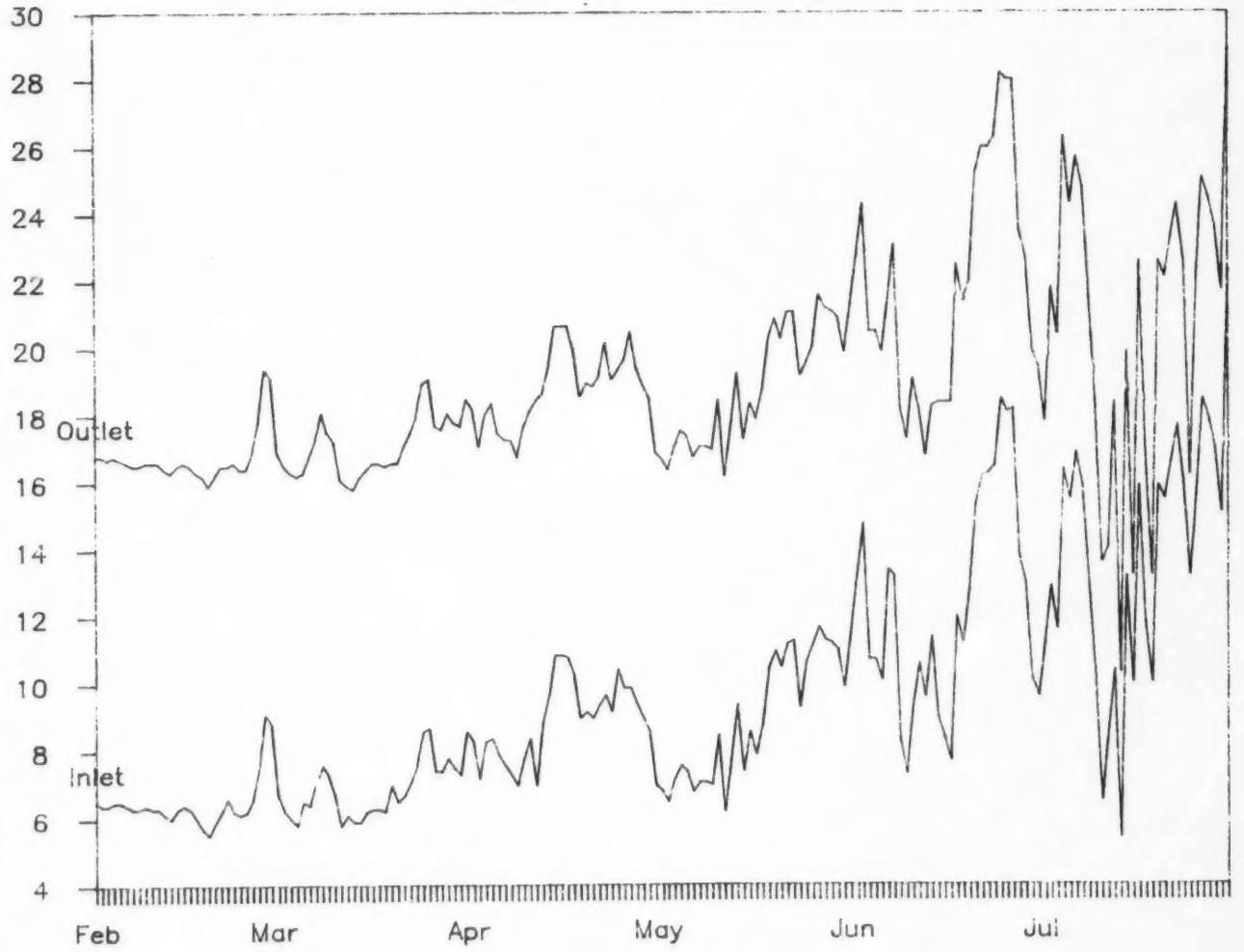
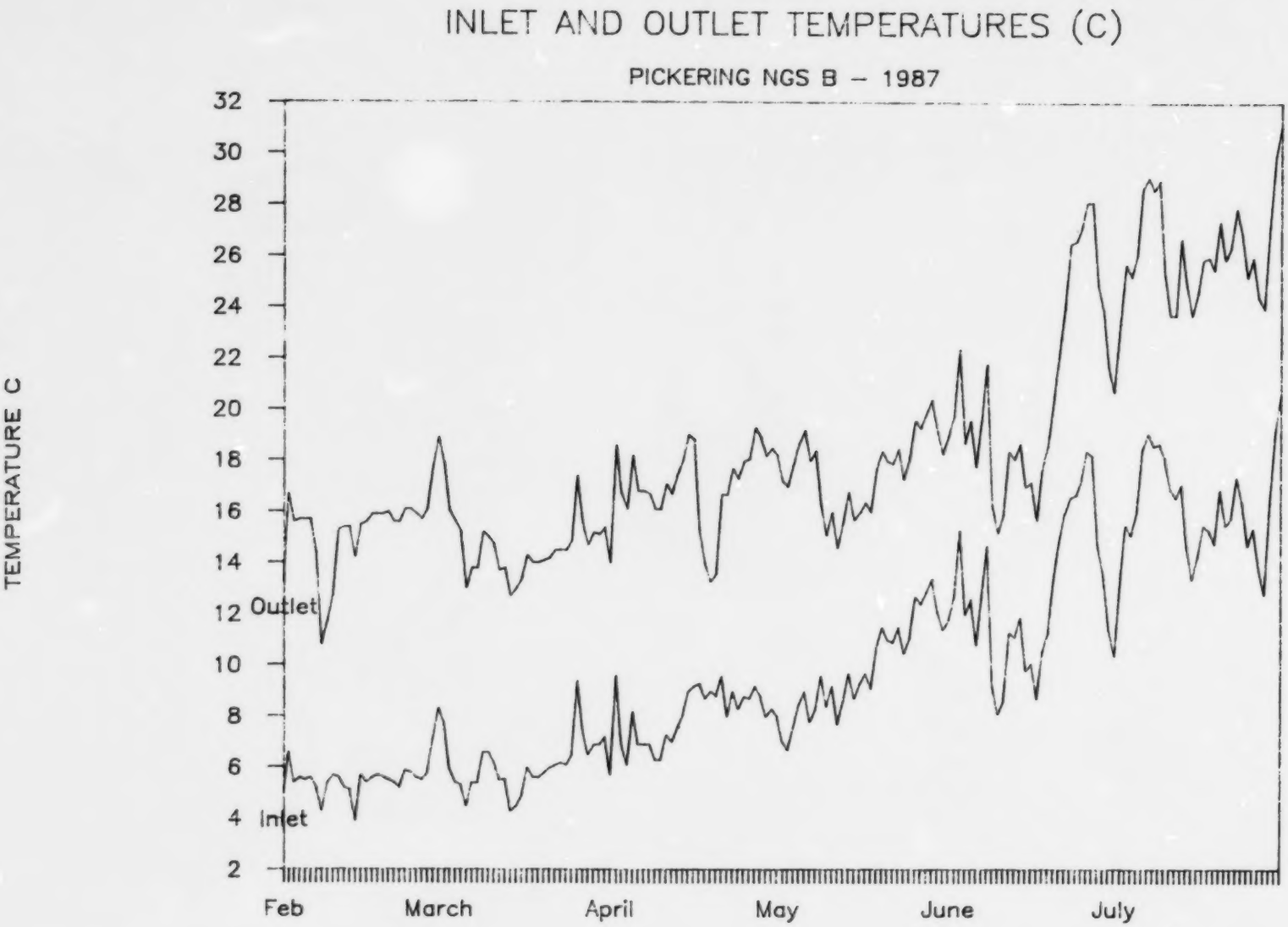


FIGURE 4


INLET AND OUTLET TEMPERATURES (C)
PICKERING NGS B – 1987
TEMPERATURE C
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Outlet
Inlet
Feb
March
April
May
June
July

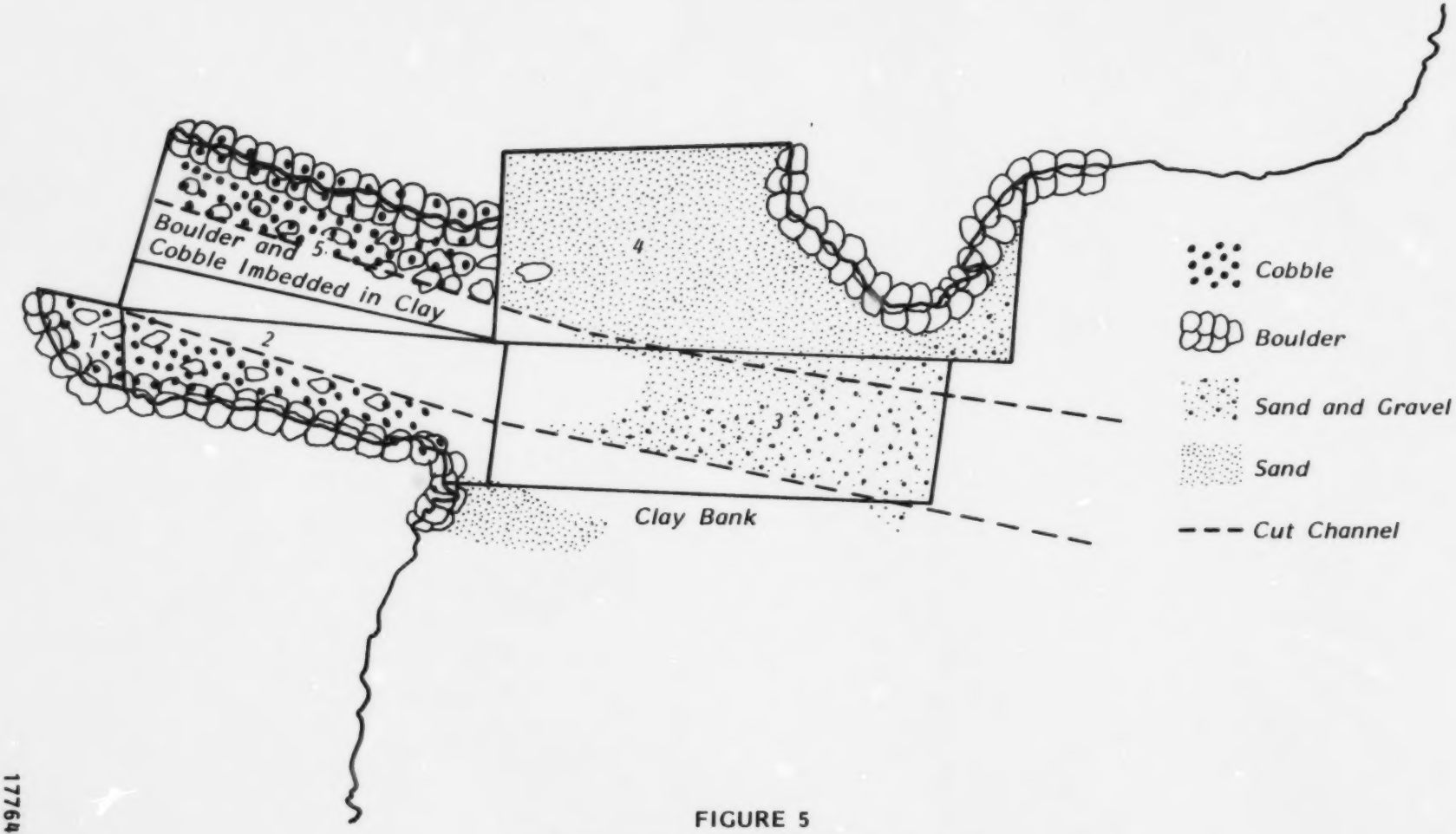


FIGURE 5

DESCRIPTION OF SUBSTRATE IN THE
PICKERING NGS 'A' DISCHARGE CHANNEL

177644-RD

The cut channel is 15.2 m wide at the immediate station discharge and extends 399 m out into the lake. The length of the channel covered by the dives was approximately 170 m starting at the station discharge.

Pickering NGS B Discharge Channel

The substrate in zones 1 and 2 was composed of a mixture of cobble and boulder (Figure 6). In the centre of the channel, in zones 3 and 5, the bottom consisted of boulder and cobble embedded in clay. Along the side at the outer end of zone 5 there was sand with some cobble and boulder. In zone 3 there was a mixture of gravel and sand along the sides with decreasing amounts of gravel toward the centre and into zone 4. Along the east side, at the end of the channel, the substrate consisted of boulder and cobble. Along the west side of the channel in zones 6 and 7 there was boulder with an increasing amount of cobble towards the end of the channel. As in the Pickering NGS A discharge channel, attached algae proliferated on the cobble and boulder along the shoreline from early spring on.

The width of the cut channel in the Pickering NGS B discharge is 15.2 m and its length is 430 m. Dives were made to a distance of about 260 m out from the immediate station discharge (outfall).

3.4 Water Currents

The descriptions of the water currents in the Pickering NGS A and Pickering NGS B discharge channels are general and limited to predominant currents.

Pickering NGS A Discharge Channel

In the Pickering NGS A discharge, lateral eddy currents persisted in the upper half of the water column along the sides of the channel in zones 2, 5 and 4 (Figure 1). In the centre of the channel and along the bottom, the current was strong and flowed straight out towards the open lake. In zone 3 the predominant current direction throughout the water column was straight out towards the open lake.

Pickering NGS B Discharge Channel

In the Pickering NGS B discharge, eddy currents prevailed in the upper half of the water column along the sides in the areas close to the immediate discharge in zones 2, 3 and 5. Along the centre and bottom, strong currents flowed straight out towards the open lake. In zones 4, 6 and 7 the predominant current direction throughout the water column was also straight out towards the open lake (Figure 2).

3.5 Discharge Residence of Fish

3.5.1 SCUBA Divers' Observations

Complete diver observations, reported as numbers of fish observed in each zone, are presented in Appendix 1 for Pickering NGS A and in Appendix 2 for Pickering NGS B.

Diver estimates of fish numbers in the Pickering NGS A discharge are summarized in Table 1. Fish belonging to 20 species were observed in the Pickering NGS A discharge. Species that were present on most diving occasions were carp, white sucker, smallmouth bass and yellow perch. Species that were present intermittently included alewife, freshwater drum, gizzard shad, rock bass, walleye, white bass and white perch.

TABLE 1

PICKERING NGS A POSTOPERATIONAL STUDY - YEAR II, 1987
DIVER ESTIMATES OF NUMBERS OF FISH PRESENT IN THE PICKERING NGS A DISCHARGE

	March 23	April 13	April 24	April 30	May 6	May 7	May 8	May 25	May 26	May 27	May 28	May 29	June 1	June 3	June 5	June 15	June 18	July 22	July 30	Total
Alewife			951	2175				1000				1000	1000		1000	1100	2000	3250	7500	13476
White Sucker		4	48	207	8	40	20	70	30	43	59	96	350	12	57	30	7	58	57	1139
Carp	94	61	128	242		35	20	35	30	8	16	42	150	26	30	20	58	92	72	1087
Gizzard Shad	130	16		78		100		1			6	15				2				348
Smallmouth Bass	34	38	21	32	9	2	10	21	6	2	8	6	23	9	27	22	16	57	132	343
Brown Bullhead													5		3			300	300	308
White Bass			22	27					10	8	2				10	16	16	100	106	211
White Perch			31	22									70		5	16	16	6	12	166
Freshwater Drum	6	2	41	46	5		10	2			12	1			7		4	20	312	156
Yellow Perch				26		5		9	1	3	1	4	31	4	2		4	8		98
Walleye	2	5	8	12	3		1	1	4		2	1	4			2	4	15	9	64
Log Perch			2	29				15												46
Rock Bass		2	2			1		1			1		2	3	1	4				17
American Eel			1	1						1	6		1	1					6	11
Channel Catfish			1															2		3
Rainbow Smelt			3																	3
Lamprey																	1			1
Black Crappie													1							1
Northern Pike												1								1
Goldfish												1								1

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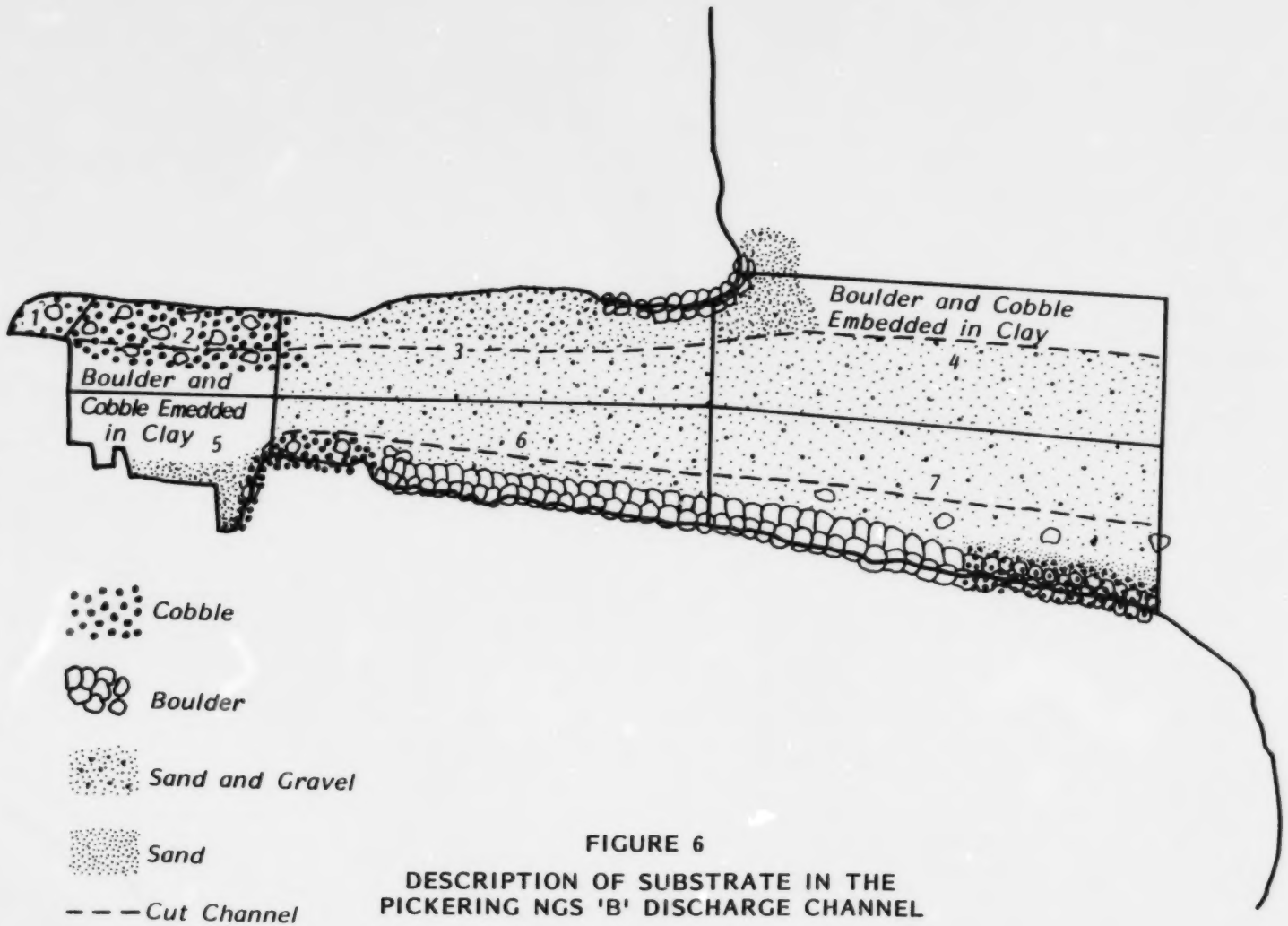

FIGURE 6

DESCRIPTION OF SUBSTRATE IN THE PICKERING NGS 'B' DISCHARGE CHANNEL

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Species commonly observed in the Pickering NGS A discharge that were only taken in low numbers (CUE<0.1) in the 1987 May-November gill net catches at the Pickering NGS A 3 and 12 m locations include carp, smallmouth bass, rock bass, walleye and white bass. Freshwater drum was not caught along the Pickering NGS A discharge transect during the May-November gill netting program.

When schools of alewife were present, they were numerically dominant. On the remaining days either gizzard shad, carp or white sucker were the most common fish species present in the Pickering NGS A discharge.

Estimates of fish observed in the Pickering NGS B discharge are presented in Table 2. Twenty fish species were identified among the fish observed in the Pickering NGS B discharge. Species that were commonly present included carp, freshwater drum, smallmouth bass, walleye and white sucker. Species present intermittently included alewife, gizzard shad, rock bass, white bass and white perch.

Carp, freshwater drum, smallmouth bass, walleye, gizzard shad, rock bass and white bass were not common (CUE<0.1) in the 1987 May-November gill net catches taken at the Pickering NGS B 3 and 12 m locations.

Carp was the most abundant species in the Pickering NGS B discharge on all but two diving occasions between February 3 and May 8. On March 23 the presence of a large school of white perch made it the most common species, while freshwater drum was the most common species present on May 7. Either carp, white sucker or freshwater drum was the most abundant species present on diving occasions between May 15 and June 12. Alewife was the most abundant on the remaining occasions.

Twenty fish species were identified among the fish observed in the Pickering NGS B discharge. Species that were commonly present included carp, freshwater drum, smallmouth bass, walleye and white sucker. Species present intermittently included alewife, gizzard shad, rock bass, white bass and white perch.

Carp, freshwater drum, smallmouth bass, walleye, gizzard shad, rock bass and white bass were not common (CUE<0.1) in the 1987 May-November gill net catches taken at the Pickering NGS B 3 and 12 m locations.

Carp was the most abundant species in the Pickering NGS B discharge on all but two diving occasions between February 3 and May 8. On March 23 the presence of a large most abundant species present on diving occasions between May 15 and June 12. Alewife was the most abundant on the remaining occasions.

3.5.1.1 Smallmouth bass *(Micropterus dolomieui)*

Pickering NGS A

Smallmouth bass were observed in the Pickering NGS A discharge channel on all diving occasions from March 23 to July 30 (Table 1). A detailed examination of locations within the discharge where smallmouth bass were observed is presented in Table 3. In April they were mainly found in zone 1 and in July they were mainly found in zones 4 and 5. During May and June, their customary spawning period (Scott and Crossman 1973), numbers to 27 fish found distributed over four zones (1, 2, 4 and 5) on June 5 (Appendix 3).

TABLE 2

PICKERING NGS B POSTOPERATIONAL STUDY - YEAR II, 1987.
DIVER ESTIMATES OF NUMBERS OF FISH PRESENT IN THE PICKERING NGS B DISCHARGE

	February 3	February 26	March 16	March 23	April 13	April 21	April 28	May 4	May 5	May 6	May 7	May 8	May 25	May 26	May 27	May 28	June 17	June 18	June 29	July 22	July 30	Total
Carp	708	652	204	154	296	220	640	40	50	50	200	50	78	330	66	46	100	20		163	413	4558
Alewife																	1000	100		1300	2000	3600
Freshwater Drum	7	167	92	50	68	68	289	8	4	10	235		31	190	10					39	48	1446
White Sucker		11			4	5	50	5	10	20	90	20	164	330	25	70	100					1424
Smallmouth Bass	59	46	32	100	48	33	43	2	24	10	6	5	7	23	12	24	4	9	24	61	13	692
White Perch	1	1		300			7				12					1				54	30	380
Gizzard Shad	72	88	123	80	4					5				2								377
Walleye	2	2	15	24	10	10	5	1		3	11	12	4	14	2		2			23	1	164
Rock Bass						1			1	0	0			10	25	5		3			1	66
White Bass	12 6				3		1		2		4			11		1				18	90	68
American Eel			1		1		2								1		1			15		54
Yellow Perch							1									1						13
Goldfish							1	1						2	2							8
Lake Trout									1		2											3
Brown Bullhead																						0
Black Crappie									1													1
Unidentified salmon					1																	1
Pumpkinseed															1							1
Coho Salmon	1																					1
Northern Pike																						1

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TABLE 3
PICKERING NGS A DISCHARGE SMALLMOUTH BASS OBSERVATIONS - AREAS 1-5

DATE	MAR 23	APR 13	APR 24	APR 30	MAY 6	MAY 7	MAY 8	MAY 25	MAY 26	MAY 27	MAY 28	MAY 29	JUN 1	JUN 3	JUN 5	JUN 15	JUN 18	JUL 22	JUL 30	TOTAL
AREA 1		29	12	20	9		NS	4	1	NS		NS		6	NS	8		4			84
AREA 2	12	3		12	NS	NS	NS	NS	NS	NS			NS	NS	NS	8	10	6			51
AREA 3	NS	NS			NS		NS	NS	NS	NS	NS	NS	4	NS	NS	NS					4
AREA 4	22	6			NS		10	15			NS	4	8	9	6	6	6	22	32	133
AREA 5			9		NS	2		2	5	2	8	2	5		5	6	NS	35	100	181
TOTAL	34	38	21	32	9	2	10	21	6	2	8	6	23	9	27	22	16	57	132	453
VISIBILITY (M)	3.5-4.0		2	2	1	2	1.5	2.0-4.0	1.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2	1.5	2	1.5	1.5	1.5	1.5	
TEMP (C)	16	16	17	15.4	19	17	16		21	21	20	22.5	22.8	20	20	19	18.5	19	26	

NS = NOT SURVEYED

The results of the tagging program conducted from April 30 to June 1 are presented in Table 4. By the end of the tagging period, a total of 26 smallmouth bass had been tagged, yet no more than 5 individuals were sighted on any single diving occasion. Visibility ranged from 1.5-2.0 m (Table 3) and was adequate for the sighting of tags on the tagged bass. The low number of sightings of tagged bass suggests that bass reside in the discharge channel for relatively short periods, and that there is a considerable turnover of individuals in the discharge.

Large numbers of alewife were often present in the discharge from the end of May onward. This provided the smallmouth bass entering the discharge from colder ambient lake waters with a good food source. On one occasion (Jun 18) a bass was observed with the tail of an alewife protruding from its mouth.

Male smallmouth bass build nests 30-180 cm in diameter in 0.6-6 m of water on sand, rock or gravel bottoms of lakes and rivers, usually near the protection of rocks, logs or occasionally, dense vegetation (Scott and Crossman 1973).

A number of areas within the Pickering NGS A discharge channel considered to be suitable for smallmouth spawning are shown in Figure 1. In some areas, such as the bottom of the discharge channel and along the sides of areas 2 and 5, the currents are too strong for nesting. Zone 1 is suitable in terms of current, however, the downward slope of the bottom and the absence of fine substrate where protective rocks are found makes this zone less than ideal for nesting. Zone 2, where the nests were found, consists of large (1 m diameter) boulders placed on the southwest corner of the discharge channel for erosion protection. Suitable areas for nest construction occur within the lee of these boulders. A similar area exists at the outer margin of zone 5. Large boulders and cobble armour the slope, but very little fine material is available for nest construction. The northern half of zone 4, within the confines of the former barge dock, would also be suitable for nest construction. The substrate here consists mainly of sand with a small amount (<10%) of gravel along the north wall. The depth decreases from 2.5 m along the north wall to 1-1.5 m along the south wall. Large boulders and cobble used as shoreline protection, with fine material in between the boulders also makes the southern half of zone 4 suitable for nesting.

Nesting activity was only observed on one occasion (Jun 5) when three cleared areas were discovered on the southwest corner of the discharge channel (zone 2). No eggs or fry were associated with the nests at that time. The nests were found to be abandoned or unused on subsequent dates (Jun 15 and 18). A number of smallmouth bass adults exhibited behaviour consistent with nesting activity (aggressive, territorial) on June 15 (zone 8) and on June 18 (zone 6). However, no new nests or fry were observed on any subsequent dives.

A forced outage of unit 4 between the early morning hours of June 12 and the morning of June 15, combined with cooler intake temperatures due to upwelling, resulted in discharge temperatures of 16-18°C. The previous week (June 1-8) water temperatures had been 20-24°C. The drop in temperature, however, is not considered to be severe enough to limit spawning activity (Shuter et al 1980).

The distribution of smallmouth bass within the channel during late May and June was undoubtedly influenced by their natural spawning instinct. Spawning behaviour in smallmouth bass is linked to primary environmental cues such as an increase in photo-period, which initiates production of gonadotrophic hormones, and increases in water temperature which sensitize gonads to the presence of these hormones. Thus recrudescence begins and proceeds at a rate which varies with temperature (Shuter et al 1980). At the proper time, site selection and nest

TABLE 4

SMALLMOUTH BASS TAGGING
PICKERING NGS 1988

	PICKERING A DISCHARGE				PICKERING B DISCHARGE			
	FISH TAGGED				FISH TAGGED			
DATE	DAILY TOTAL	CUMUL TOTAL	TAGGED INDIVID. OBSERV.	RECAPT.	DAILY TOTAL	CUMUL TOTAL	TAGGED INDIVID. OBSERV.	RECAPT.
APR 30	10	10	1					
MAY 4					1	1		
MAY 5					4	5		
MAY 6	3	13			1	6		
MAY 7			1				1	
MAY 8	1	14			3	9		
MAY 25	7	21	3		3	12		
MAY 26	1	22	2				1	
MAY 27			1		4	16	1	
MAY 28	1	23	1		2	18	4	
MAY 29	1	24	2		4	22		
JUN 1	2	26	4		1	23	3	
JUN 3					1	24		
JUN 5			5				2	
JUN 7								1
JUN 8							1	
JUN 12							1	
JUN 15			2					
JUN 16			2					
JUN 18			1					
JUL 22								
JUL 30								
TOTAL	26	26		0	24	24		1

building commences, with spawning normally taking place within a temperature range of 15 to 21°C, although smallmouth bass are assumed to be capable of spawning at up to 27°C. Temperatures within the discharge channel were consistently above 15°C during all of May and June and reached a maximum of 28.2°C in late June (Figure 3). These temperatures are within the range that is suitable for smallmouth bass spawning.

Fish entering the discharge channel from lake ambient temperatures would have their probable date of spawning influenced by the higher discharge temperatures. Shuter et al (1980) developed a relationship between these events, defined as a rise in temperature from a level below 15°C to a level above 15°C, followed by spawning and the number of day-degrees above 10°C accumulated by the date temperatures reached 15°C. In his model the number of spawning events increased with time spent at temperatures above 10°C up to approximately 125 degree days above 10°C. Beyond this point exposure to temperatures above 10°C resulted in declining numbers of spawning events. According to this relationship, smallmouth bass that reside in the discharge for long periods of time would have their chances of spawning reduced while those that spent short intervals in the discharge would spawn earlier than at ambient conditions. Results of the tagging program as well as the date of nesting recorded in the Pickering NGS A discharge indicate that smallmouth bass do not reside there for long periods.

The low level of nesting success within the Pickering NGS A discharge channel can also be related to its orientation and length. Areas considered to be most suitable for nesting (Figure 1) are also most readily disturbed by wave action. The orientation of the discharge channel is directly in line with prevailing winds (southwest during spring-summer) increasing the chance of nest disturbance or destruction during storm events.

Pickering NGS B discharge

Smallmouth bass were present in the Pickering NGS B discharge on all diving occasions from February 3 to July 30. Numbers observed ranged from 2 on May 4 to 100 on March 23 (Table 2).

The number of smallmouth bass within the seven zones of the discharge channel during each diving occasion is presented in Table 5. Visibility and water temperature during the dive are also presented. The smallmouth bass were most often found on the east side of the channel, near the junction of zones 3 and 4 (Figure 2) during the winter and early spring dives. By late May, they were more abundant along the west side of the channel and were found to be spawning along much of the shoreline area of zone 6. In the last week of July they were found to be more evenly distributed throughout the discharge.

A total of 24 smallmouth bass were tagged between April 30 and June 3 (Table 4). The maximum number of tagged fish observed during a single dive was 4. As in the case of the Pickering NGS A discharge, this suggests that the smallmouth bass reside in the discharge for relatively short intervals and that there is a considerable turnover of individuals in the Pickering NGS B discharge.

Primary and secondary spawning areas on the west side of the discharge channel were identified according to their suitability as spawning habitat (Figure 2). The primary spawning areas provided a stable physical environment which provided excellent protection for eggs and fry from physical disturbance and predation. They consisted of a series of spaces behind and between boulders used to armour the shoreline, which are easily guarded by adult males.

This area, being on the west side of the discharge channel is also protected from wave action during storm events and by the outward flow of the discharge current itself. This serves to

dissipate wave action before reaching the nesting area. In addition, the area is recessed 5-6 m into the shoreline providing protection from the discharge current which could sweep away newly hatched larva from unprotected locations.

A small back eddy exists immediately in front of the primary area, providing a gentle, northward flow of water past the face of the boulders. This provides a continuous exchange of water through the area, ensuring that stagnation, oxygen depletion or excessive temperature rise does not occur between the boulders.

The area is also suitable for smallmouth bass nesting in terms of temperature. Various authors (Shuter et al 1980) have noted that survival of eggs and larvae on the nests is greatest when temperatures are in the 15-27°C range. Below 15°C, males commonly desert the nest, leaving eggs and fry vulnerable to predation. Temperatures below 10°C and above 30°C are usually lethal to the eggs and fry (Wren 1984).

Examination of the outlet temperature records for the discharge channel for May and June (Figure 4) indicate only one occasion when the mean daily temperature dropped below 15°C (May 12, 14.6°C). Thus temperatures were never in the lethal range. Conversely, inlet temperatures, which were taken to represent ambient temperature conditions, did not consistently exceed 15°C until June 21. Prior to this, a number of days with mean daily temperatures around 13°C occurred near the end of May and in the first week of June. Temperatures remained low for the subsequent two weeks and remained below 10°C from June 9 to 11. This would undoubtedly have been lethal to eggs and larvae.

Spawning within the Pickering NGS B discharge took place along the western margin of the channel as indicated in Figure 2. The initial 35 m of the nesting area appeared to be the most favoured, being the first to be utilized by spawning smallmouth bass. Possible nesting behaviour was noted in this area on May 28. All smallmouth bass found in this area on May 29 were found along the face of the boulders in 1-2m of water. Nests with eggs and/or fry were not observed until June 3, 1987, when five nests were found. One nest contained eggs, and four contained unrisen fry (Table 6). Two days later, nine nests were observed with broods in varying stages of development, ranging from eggs to risen black fry. By June 12, 11 nests were observed, with broods ranging in development from unrisen black fry to black fry dispersed up to 2 m from the nest site. A new nest containing eggs was observed on June 15, bringing the total number of nests observed in the area to 12.

Smallmouth bass have also been found in the Nanticoke TGS discharge in the winter months during a discharge residency study conducted there in 1983-1984 (Ontario Hydro Research Division Report No 87-228-K). They were also found spawning in the Nanticoke TGS discharge during that study.

Using formulas presented in Shuter et al (1980), the hatch time and spawning date of fry assumed to have risen from the nest on June 5, the date fry were first observed in the Pickering NGS B discharge were calculated. Mean daily temperature on that date was 19.6°C. A period of 6.3 days was obtained for the hatch to rise period by applying the formula:

$$t_{HR} = 134\, e^{-0.1606T}$$

That brings the hatch date to May 30. A period of 3.9 day was obtained by using the formula for fertilization to hatch:

$$t_{SH} = 83.2\, e^{-0.1606T}$$

TABLE 5

PICKERING B DISCHARGE
SMALLMOUTH BASS OBSERVATIONS AND NESTING ACTIVITY (AREAS 1-7)

DATE	FEB 3	FEB 26	MAR 16	MAR 23	APR 13	APR 21	APR 28	MAY 4	MAY 5	MAY 6	MAY 7	MAY 8	MAY 25	MAY 26
AREA 1	8	--	6	28	3	2	5	2	1	NS	1	5	4	1
2	4	1	4	10	1	7	14	--	--	NS	--	--	--	--
3	--	7	15	37	--	10	11	NS	1	NS	--	--	--	1
4	30	19	7	25	33	10	3	NS	22	10	5	NS	3	1
5	6	7	--	--	--	--	NS	NS	NS	NS	NS	NS	NS	NS
6	3	10	--	--	10	3	7	NS	NS	NS	NS	NS	NS	20
7	8	2	--	--	1	1	3	NS	NS	NS	NS	NS	--	NS
TOTAL	59	46	32	100	48	33	43	2	24	11	6	5	7	23
VISIBILITY	1.0-1.5	3	1	3.5-4.0	1.5	1.0-1.5	1.5-2.0	1.5-2.0	1.5-2.0	1.5	1.5-2.0	2.0	2.0-3.0	1.0-3.0
TEMP (C)	15	--	13	11	17	20	17	19	17	19	17	17	15	21

DATE	MAY 27	MAY 28	MAY 29	JUN 1	JUN 3	JUN 5	JUN 8	JUN 12	JUN 15	JUN 16	JUN 17	JUN 18	JUN 29	JUL 22	JUL 30
AREA 1	NS	3	NS	--	--	NS	NS	--	--	NS	--	NS	NS	30	3
2	NS	--	NS	--	--	NS	NS	--	1	NS	--	NS	NS	4	--
3	NS	--	NS	--	8	NS	NS	--	--	NS	--	NS	NS	2	3
4	NS	8	NS	4	4	NS	NS	--	1	NS	--	NS	NS	6	
5	--	NS	NS	--	--	NS	NS	--	1	--	--	--	NS	8	2
6	12	13	9	14	7	10	19	16	10	8	4	7	24	6	4
7	NS	NS	1	--	--	7	5	3	--	--	--	2	NS	5	1
TOTAL	12	24	10	18	19	17	24	19	13	8	4	9	2	61	13
VISIBILITY	2.0-3.0	2.0-3.0	2.0-3.0	2.0	1.5	2.0	1.0-2.0	2.0-3.0	1.0-2.0	--	1.0-2.0	2.0	2.5	1.5	1.5
TEMP (C)	21	20	22.5	21	20	20	24	21	19	--	19	18.5	23	27	29

NS = NOT SURVEYED

bringing the spawning date to May 26.

Thus, assuming that the fry observed on June 5th were the earliest to rise in the Pickering NGS B discharge, then the earliest spawning date was May 26 and the earliest hatch date was May 30. This spawning date is within the normal spawning period (May-June) for smallmouth bass in Ontario (Scott and Crossman 1973).

As in the case of the Pickering NGS A discharge, tagging results and the timing of spawning indicate that the smallmouth bass do not spend long periods in the Pickering NGS B discharge and that turnover of individuals in the discharge is high.

The results of the present study suggests that the presence of the station may result in an increase in the local smallmouth bass population by providing suitable spawning habitat.

3.5.1.2 Gizzard Shad (*Dorosoma cepedianum*)

The numbers of gizzard shad in the Pickering NGS A discharge were quite variable. The largest number of shad was observed on March 23, the first day that diving was conducted in the Pickering NGS A discharge, when 130 shad were counted. Shad were found only in very low numbers after the first week in May. The higher numbers observed between end-March and early-May was probably part of their spring spawning migration.

In the Pickering NGS B discharge the occurrence of shad was generally limited to the period between the first dive on February 3 and March 23. They were only present intermittently in very low numbers during the remainder of the study period. This was quite different from their occurrence in the Pickering NGS A discharge where numbers did not decline until May. The largest number of shad in the Pickering NGS B discharge was observed on March 16 when 130 fish were counted.

Gizzard shad were concentrated in the eddy currents in zone 4 in the Pickering NGS A discharge and in zones 2 and 3 in the Pickering NGS B discharge. In the Nanticoke TGS discharge, shad were also typically found in eddy currents (Ontario Hydro Research Division Report No 87-228-K).

During the present study, gizzard shad were never present in very high numbers in either of the discharges. However, observations in the present study are limited to March through July for the Pickering NGS A discharge and February through July for the Pickering NGS B discharge. Due to the limited winter observations, trends in the numbers of shad utilizing the discharge could not be established. Therefore, their presence in only low numbers during the present study period does not necessarily preclude the possibility of massive impingement of shad at Pickering NGS.

In the winter gizzard shad have been found to concentrate in areas into which warm waters flow (Bodola 1966). Gizzard shad preference for the Pickering NGS A and B discharge was apparent during the Pickering NGS B preoperational study and the 1986 postoperational aquatic study (OHRD Report Nos 84-135-K and 87-194-K).

Massive impingement of gizzard shad during winter has been reported at several Ontario Hydro generating stations (OHRD Report Nos 77-400-K and C78-31-K). Such an event occurred at Pickering NGS A in 1978 during a severe winter storm (Ontario Hydro Research Division Report No 80-226-K) when in excess of 35,000 kg of shad was impinged. Overwintering of large numbers of gizzard shad in the Pickering NGS A discharge was observed in the winter of 1975-

1976 (OHRD Report No 80-226-K).

Impingement of shad had declined considerably between 1978 and 1985. In 1985 yearly impingement of gizzard shad totaled a mere 31.3 kg. However, since then shad impingement jumped to 9,800 kg over a two-day period (February 8 & 9, Pope in draft) in 1986 indicating considerable fluctuation in yearly impingement of shad at Pickering NGS. Between January and March of 1987 no gizzard shad were impinged at Pickering NGS A and only 0.2 kg was impinged at Pickering NGS B (RMEP-IR-07000-16).

Maximum monthly impingement of gizzard shad at Pickering NGS (1978-1986) has generally been found to occur either in one of the winter months of December, January or February, or in the months of March or April. Higher impingement in the winter months suggests the concentration of shad in the warmer waters of the thermal plume during winter while higher impingement in spring was probably a result of inshore spawning migration. Monthly gill netting in the Pickering NGS A and B discharges from May through November conducted from 1979 to 1981 (Ontario Hydro Research Division Report No 84-135-K) and in 1986 (Ontario Hydro Research Division Report No 87-194-K) produced largest numbers of shad in October or November. The higher catches in the fall suggest movement of shad into the discharges as ambient water temperatures dropped.

The continuation of fish discharge residency studies in the winter of 1987-1988 should provide further information on gizzard shad utilization of the thermal discharges.

3.5.1.3 Walleye (*Stizostedion vitreum*)

The numbers of walleye observed in the Pickering NGS A discharge between March 23 and July 22 were low. The highest number was found on July 22 when 15 were counted. In the Pickering NGS B discharge the largest number was observed on March 23 when 25 fish were counted. The somewhat larger numbers observed in March than in February in the Pickering NGS B discharge may have been part of the spawning migration, although no spawning activity was observed.

It was hypothesized that the different orientation of the Pickering NGS B discharge and the large enclosed channel would make this discharge more attractive to walleye than the Pickering NGS A discharge (Greig et al 1986). The larger numbers of walleye found in the Pickering NGS B discharge during this study appears to support this hypothesis.

The walleye were found in the centre of the discharge channels, close to the bottom in strong currents over substrate of sand and gravel, a preferred substrate type for walleye (Kitchell et al 1977). In the Pickering NGS A discharge, this was the area close to the edges of the west and east sides of the channel (zones 5 and 2), while in the Pickering NGS B discharge it was in the centre of the channel around zones 3 and 6.

The position of the walleye in the discharge channels demonstrates their preference for strong currents, and, that as hypothesized, they may be attracted to the discharge by the strong currents. However, large influxes of walleye at their anticipated spawning time in March-April were not observed and those walleye present in the discharges at that time were not observed to be spawning. Thus during the present study low larval survival due to asynchrony with food supply and entrainment was not a threat and the physical presence of the Pickering station should not have resulted in decreased walleye stocks. However, since there were some walleye that may have been attracted to the discharge current, the possibility of large numbers of walleye being attracted to the discharge in the future and remaining there to spawn cannot be ruled out.

TABLE 6

SMALLMOUTH BASS NESTING ACTIVITY
PICKERING B DISCHARGE 1987

STAGE	OBSERVATION DATE MAY 28	MAY 29	JUN 1	JUN 3	JUN 5	JUN 8	JUN 12	JUN 15	JUN 16+	JUN 17	JUN 18+	JUN 29
NEST WITH EGGS (1)				1	3			1				
NEST WITH BLACK UNRISEN FRY (4)				4	2	2	4					
NEST WITH BLACK RISEN FRY (50%)(6)							1			2		
NEST WITH BLACK RISEN FRY (100%) DISPERSED UP TO TWO M FROM NEST SITE (8)					4	3	6		7	2	7	5
GREEN FRY (9)									2			5
ADULT SHOWING NESTING BEHAVIOR	1				2						2	
ADULTS ASSOC. WITH NESTING AREA -												
UNTAGGED	9	7	5	8		7	11		6	4	7	10
TAGGED	3	1	2		1	1	1		2			
TEMP(C)												
DISCHARGE	20	22.5	21.0	25.0	20.0	24.0	21.0	19.0	21.5	19.0	18.5	23.0
MEAN *		20.4	19.0	22.4	19.6	21.8	18.4	17.0	17.2	15.7	17.7	23.9
MIN-MAX *		18.4-21.6	17.6-20.5	20.5-25.1	16.9-21.1	16.9-24.6	16.3-20.9	14.4-21.6	13.5-20.1	13.0-17.8	16.2-19.9	21.9-26.0

FROM VIDEOTAPE OF NESTING SITE - +
HYDRAULIC STUDIES DATA - *

3.5.1.4 Carp (*Cyprinus carpio*)

Carp were present in the Pickering NGS A discharge on all diving occasions from March 23 to July 30, with the largest number observed on April 30. In the Pickering NGS B discharge, the largest number of carp (approximately 800) were observed on February 26. Divers observed that carp were most often found along the sides of the discharge channels, oriented into the current, feeding on algal growth on the boulder and cobble.

3.5.1.5 White sucker (*Catostomus commersoni*)

White sucker were present in the Pickering NGS A discharge on all but one occasion. Numbers observed varied considerably with a maximum of about 350 individuals found on June 1. In the Pickering NGS B discharge, larger numbers were present in May and June coincident with their expected inshore spawning migration period (Scott and Crossman 1973). A maximum of two hundred white sucker were estimated to be present in the Pickering NGS B discharge on May 15 and 26.

In the Pickering NGS A discharge, this species was often found swimming upstream along sand substrate, drifting back downstream, and then repeating the upstream movement.

3.1.5.6. Freshwater Drum (*Aplodinotus grunniens*)

This species occurred in lower numbers in the Pickering NGS A discharge than in the Pickering NGS B discharge where they were occasionally found in high numbers. In the Pickering NGS A discharge the largest number were observed in late April when in excess of 40 freshwater drum were counted. In the Pickering NGS B discharge the largest number of freshwater drum were found on May 7 when 235 were present.

Freshwater drum were actively swimming along the sides and in the eddy currents in both discharges. Their presence in the discharges is not unexpected since they are known to be inhabitants of shallow waters (Scott and Crossman 1973).

3.1.5.7 Alewife (*Alosa pseudoharengus*)

The surge of alewife into the discharges occurred earlier in the year at Pickering NGS A than at Pickering NGS B. Large schools of alewife were first observed on April 24 in the Pickering NGS A discharge and on June 15 in the Pickering NGS B discharge. The occurrence of alewife in the Pickering NGS A discharge in April coincides with the time of year they begin their inshore movement from deeper waters (Graham 1957).

Although present throughout the discharge channels the alewife were more frequently found in the back eddies. Graham's (1957) description of the milling and "rollercoaster" movements of the schools aptly describes their swimming pattern in the discharges.

3.1.5.8 White Bass (*Morone chrysops*)

The occurrence of white bass in the two discharges was sporadic with largest numbers found on July 22 when 100 were observed at Pickering NGS A and 18 were observed at Pickering NGS B. This species was more abundant in the Pickering NGS A discharge than in the Pickering NGS B discharge. White bass were actively swimming along the sides of the discharge channels.

This species has demonstrated a preference for the heated discharge waters in the fall during

previous aquatic biological studies conducted at Pickering NGS B (Ontario Hydro Research Division Report No 84-135-K, 87-149-K and 87-194-K). A study on radio-tagged white bass suggested that they remained in the Pickering NGS A discharge for at least several days at a time, rather than entering it diurnally or for brief periods (Ontario Hydro Research Division Report No C79-3-K). This attraction to the discharge increases the vulnerability of this game fish to anglers (Ontario Hydro Research Report No 87-228-K).

A study was conducted in 1977-1978 to identify the food and determine the condition of white bass in the Pickering NGS A discharge. White bass was selected for study at that time because it was one of the most abundant of several sport fishes inhabiting the discharge and was the object of anglers at this location (Ontario Hydro Research Division Report No 79-218-K). The data indicated that the food intake of white bass in the discharge as well as at a control site was moderate throughout the year. The condition factor of the fish increased from April to November when they were slightly higher than those of fish from a control location.

3.1.5.9 White Perch (*Morone americana*)

White perch were not observed in the Pickering NGS A discharge on diving occasions in May while the highest number was observed on June 1 when an estimated 70 fish were present. The occurrence of white perch in the Pickering NGS B discharge was sporadic and with the exception of the large numbers present on March 23 and July 22 (54 fish), the numbers were very low. A large school of approximately 350 white perch was present in the Pickering NGS B discharge on March 23. The formation of dense schools of this species is believed, in part, to be associated with feeding (Scott and Crossman 1973).

In the Pickering NGS A discharge white perch were seen swimming actively against the current in the centre of the channels, at the periphery of the eddy currents. The large school present in the Pickering NGS B discharge on March 23 was congregated along the rip rap in zones 1 and 2.

Like white bass, white perch demonstrated a preference for the heated discharge areas in the fall during previous studies conducted at Pickering NGS B.

3.1.5.10 Rock Bass (*Ambloplites rupestris*)

In the Pickering NGS A discharge rock bass were only found sporadically in very low numbers ($\leq$ 4). They were more abundant in the Pickering NGS B discharge where they were first observed in mid-April. The largest number in the Pickering NGS B discharge was observed on May 27 when 25 rock bass were present.

3.1.5.11 Yellow Perch (*Perca flavescens*)

Although frequently present in the Pickering NGS A discharge, yellow perch were only found in low numbers during most dives. Exceptions were found on April 30 and June 1 when 26 and 31 yellow perch, respectively, were observed. This species was not as common in the Pickering NGS B discharge as it was in the Pickering NGS A discharge.

In the Pickering NGS A discharge yellow perch were found concentrated along the sides in zone 4 where calmer water prevailed.

3.5.2 Gill Net Catches

Walleye spawning activity occurs at night and often only over a period of a few days (Ryder

1977). Such nocturnal fish movements would have been missed in the diving observations which were made during the daytime. Gill nets were set to determine whether walleye were moving into the discharge during the night. At the same time a picture of the fish composition at the periphery of the discharges was obtained.

Gill net catch data are presented in Table 7 for the Pickering NGS A discharge and in Table 8 for the Pickering NGS B discharge.

Pickering NGS A Discharge

Five nets were fished at the periphery of the Pickering NGS A discharge between March 24 and April 28, 1987. A total of 750 fish belonging to 13 species were taken in the five nets. Alewife, followed by rainbow smelt and white sucker, was the most common species in the total catch. Only seven fish were caught on March 24, most of which were white sucker. Rainbow smelt was the most abundant species in the April 14 catch while alewife was the most abundant species in the remaining gill net catches.

Alewife and rainbow smelt were part of the catch on all fishing occasions except March 24. White sucker was the only species taken on all five dates.

During the 1987 May to November gill netting program, alewife was also the most abundant species taken in nets at the Pickering NGS A discharge followed by yellow perch and white sucker. Average catch of rainbow smelt in May-November (CUE<1.6) was substantially lower than their March-April catch. May-November average catches of lake trout (1.6), brown trout (3.9) and round whitefish (3.0) were quite similar to those of March-April.

Species taken in nets but not observed during dives included brown trout, lake trout, round whitefish, lake whitefish, longnose sucker and lake chub. Differences in species composition of gill net catches and diver observations are not unexpected since the nets were set at the periphery of the discharge and dives were limited to the discharge channel.

The absence of walleye from the gill net catches and the absence of eggs from the discharges, suggests that there probably were no large influxes of spawning walleye into the Pickering NGS A discharge at night.

Pickering NGS B Discharge

Gill nets were set at the periphery of the Pickering NGS B discharge on six occasions between March 23 and April 28. A total of 485 fish belonging to 13 species were taken. Gill net catch increased from 12 on March 23 to 263 on April 28. Alewife followed by white sucker was the most common species in the total catch.

Gill net catch on March 23 consisted of only 12 gizzard shad. Lake trout was the most common species taken on March 24 and April 14 while alewife was the most common species taken on the remaining three dates.

Alewife was also the most abundant species in the May-November gill net catch at the Pickering NGS B discharge, although the average catch (198.6) was considerably higher than in the March-April catch. White sucker was also the second most common species in the May-November catch; however, their average catch (7.0) during that period was lower than that for March-April. Lake trout, brown trout, round whitefish, and walleye catches were all lower in May-November than in March-April.

TABLE 7

PICKERING NGS B POSTOPERATIONAL STUDY - YEAR II, 1987
PICKERING NGS A DISCHARGE GILL NET CATCH

	MARCH 24	APRIL 7	APRIL 14	APRIL 22	APRIL 28		Total	CUE
	Number of fish							
ALEWIFE		375	17	108	82		582	116.4
RAINBOW SMELT		10	44	6	3		63	12.6
WHITE SUCKER	4	18	4	12	15		53	10.6
BROWN TROUT		2	6		9		17	3.4
ROUND WHITEFISH		10		3	2		15	3
LAKE TROUT	2		1	5	3		11	2.2
LAKEWHITEFISH		1		1			2	0.4
WHITE PERCH			1	1			2	0.4
ROCK BASS					1		1	0.2
LONGNOSE SUCKER				1			1	0.2
LAKE CHUB		1					1	0.2
YELLOW PERCH		1					1	0.2
WHITE BASS	1						1	0.2
Total	7	418	73	137	115	0	750	150

TABLE 8

PICKERING NGS B POSTOPERATIONAL STUDY - YEAR II, 1987
PICKERING NGS B DISCHARGE GILL NET CATCH

	MARCH 23	MARCH 24	APRIL 7	APRIL 14	APRIL 22	APRIL 28	Total	CUE
	Number of fish							
ALEWIFE			29	5	73	95	202	33.7
WHITE SUCKER		2	11	4	16	119	152	25.3
BROWN TROUT		1	12	1	6	27	47	7.8
LAKE TROUT		8	1	9	6	8	32	5.3
GIZZARD SHAD	12	1	2	2			17	2.8
RAINBOW SMELT			3		5	7	15	2.5
ROUND WHITEFISH		1	3		8	1	13	2.2
CARP		3	2				5	0.8
ROCK BASS		1		1		3	5	0.8
WHITE PERCH			1		1	1	3	0.5
FRESHWATER DRUM			2			1	3	0.5
YELLOW PERCH					1	1	2	0.3
LONGNOSE SUCKER					1		1	0.2
TOTAL		17	66	22	117	263	485	80.8

Species that were not observed in the discharge channel but were part of the gill net catch included brown trout, round whitefish and longnose sucker.

Walleye were also absent from the Pickering NGS B gill net catches and eggs were not observed in the Pickering NGS B channel, suggesting that no large influxes of spawning walleye had occurred.

4.0 SUMMARY AND CONCLUSIONS

1. Carp, white sucker, smallmouth bass and yellow perch were present in the Pickering NGS A discharge on most diving occasions between March 23 and July 22. Alewife, freshwater drum, gizzard shad, rock bass, walleye, white bass and white perch were present intermittently.

2. Generally, when alewife were present in the Pickering NGS A discharge, they were the most abundant species. Other species that were found to be the most abundant on occasion were gizzard shad, carp, white sucker and brown bullhead.

3. Species commonly present in the Pickering NGS B discharge between February 3 and July 22 were carp, freshwater drum, smallmouth bass, walleye and white sucker. Those present intermittently included alewife, gizzard shad, rock bass, white bass and white perch.

4. Carp was the most abundant fish species present in the Pickering NGS B discharge on all but two diving occasions between February 3 to June 12. White perch was the most abundant on one of these days and freshwater drum on the remaining day. Between June 15 and July 22, alewife was the most numerous.

5. The attraction of game fish such as smallmouth bass, white bass and walleye to the discharges increases their vulnerability to anglers.

6. Low number of sitings of tagged smallmouth bass and spawning observations suggested that they spent relatively short periods in the discharges and that turnover of individuals in the discharges was high. Smallmouth bass spawned in the Pickering NGS B discharge with nests and fry first observed on June 3. The nests were located in protected areas where the water was calm preventing offshore displacement and entrainment of larvae through the condenser cooling system. The spawning of smallmouth bass in the Pickering NGS B discharge may result in an increase in the local population.

7. Gizzard shad were not present in very high numbers in either of the discharges. Maximum number observed in each of the two discharges during individual dives was 130. The low numbers observed during the present study does not necessarily preclude the possibility of massive impingement of shad at Pickering NGS since the number of winter observations were limited. In addition impingement records of gizzard shad indicates that yearly fluctuation can be considerable. Continuation of fish discharge residency studies in 1987-1988 may provide more information on their seasonal occurrence in the Pickering NGS A and B discharges.

8. Diving observations indicated that walleye numbers in the discharges were low. Larger numbers were found in the Pickering NGS B discharge than in the Pickering NGS A discharge. Large influxes of walleye at their anticipated spawning time was not observed. Neither were there any signs of spawning activity. However, their position in the discharge

currents suggested that they were attracted to the discharge by the strong currents. Thus the possibility of large influxes of spawning walleye into the discharges in the future cannot be ruled out.

9. Gill net catches at the periphery of the discharges gave no indication of influxes of walleye into the discharges during their spawning period.

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KEY FOR APPENDICES

ABBREVIATIONS:

NS= Not Sampled
P= Present but not counted

FISH SPECIES:

A EEL	AMERICAN EEL
ALEWIFE	ALEWIFE
B BULLHEAD	BROWN BULLHEAD
B CRAPPIE	BLACK CRAPPIE
CARP	CARP
CHAN CAT	CHANNEL CAT
COHO	COHO SALMON
FWD	FRESHWATER DRUM
GOLDFISH	GOLDFISH
GZS	GIZZARD SHAD
LAMPREY	LAMPREY
LOG PERCH	LOG PERCH
L TROUT	LAKE TROUT
N PIKE	NORTHERN PIKE
PUMPKINSEED	PUMPKINSEED
RB	ROCK BASS
SMB	SMALLMOUTH BASS
SMELT	SMELT
W BASS	WHITE BASS
W PERCH	WHITE PERCH
WS	WHITE SUCKER
Y PERCH	YELLOW PERCH

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: MAR 23\87			NS		NS	
SPECIES: SMB		12		15		27
FWD				6		6
GZS				130		130
CARP	18	24		52		94
WALLEYE	2					

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: APR 13\87			NS			
SPECIES: SMB	29	3		6		38
FWD				2		2
GZS	4			11	1	16
CARP	8	15		30	8	61
WALLEYE	1			2	2	5
WS		2			2	4
RB				2		2

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: APR 24\87						
SPECIES: SMB	12				9	21
FWD	4	15	30		2	51
GZS						0
CARP	20	50	20		38	128
WALLEYE	1	5			2	8
WS		2	30	7	9	48
RB			2			954
CHAN CAT	1					1
ALEWIFE	1	400	200	150	200	951
W PERCH		21	10			31
W BASS		21			1	22
SMELT			3			3
LOG PERCH		2				2
A EEL					1	1

LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: APR 30\87						
SPECIES: SMB	20	12				32
FWD	6	25	6	3	6	46
GZS	6	17		30	25	78
CARP	25	65	23	80	49	242
WALLEYE		4		2	6	12
WS	9	59	20	82	37	207
ALEWIFE		75	1000	600	500	2175
W PERCH				10	12	22
W BASS		5		10	12	27
SMELT						0
LOG PERCH		4			25	29
A EEL					1	1
Y PERCH	1			25		26

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: MAY 7\87		NS	NS			
SPECIES: SMB						
FWD	P					
GZS				100		100
CARP	P			20	15	35
WS	P			30	10	40
RB					1	1
Y PERCH				5		5

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: MAY 8\87	NS	NS	NS		NS	
SPECIES: SMB				10		10
FWD				10		10
CARP				20		20
WALLEYE				1		1
WS				20		20

APPENDIX:1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: MAY 25\87		NS	NS			
SPECIES: SMB	4			5	12	21
FWD	2					2
GZS				1		1
CARP	20				15	35
WALLEYE				1		1
WS	20			30	20	70
ALEWIFE				SCHOOL	SCHOOL	0
W BASS	2			6	2	10
LOG PERCH					15	15
Y PERCH				9		9
RB				1		1

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: MAY 26\87		NS	NS			
SPECIES: SMB	1				5	6
FWD	P					0
CARP	P				30	30
WALLEYE					4	4
WS	P				30	30
W BASS	4			4		8
Y PERCH				1		1

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: MAY 27\87	NS	NS	NS			
SPECIES: SMB					2	2
CARP					8	8
WS				3	40	43
A EEL					1	1
Y PERCH				2	1	3

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: MAY 28\87			NS	NS		
SPECIES: SMB		1			8	9
FWD					12	12
GZS					6	6
CARP		6			10	16
WALLEYE					2	2
WS		24			35	59
RB					1	1
W BASS					2	2
Y PERCH					1	1
A EEL					6	6

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: MAY 29\87	NS	NS	NS			
SPECIES: SMB				4	2	6
FWD				1		1
GZS					15	15
CARP				12	30	42
WALLEYE					1	1
WS				9	60	69
ALEWIFE					SCHOOL	0
N PIKE				1		1
GOLDFISH					1	1
Y PERCH				4		4

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: JUNE 1\87		NS				
SPECIES: SMB	6		4	10	5	25
CARP	50			50	50	150
WALLEYE				1	3	4
WS	50			200	100	350
RB			1		1	2
CHAN CAT						0
ALEWIFE	SCHOOL				SCHOOL	0
W PERCH	20			50		70
Y PERCH				30	1	31
B BULLHEA	1			4		5
A EEL					1	1
B CRAPPIE					1	1

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: JUNE 3\87	NS	NS	NS			
SPECIES: SMB				9		9
CARP				25	1	26
WS				12		12
RB				3		3
A EEL				1		1
Y PERCH				4		4

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: JUNE 5\87			NS			
SPECIES: SMB	8	8		6	5	27
FWD	7					7
CARP	30	P				30
Y PERCH				2		2
WS	30	P		7	20	57
RB				1		1
ALEWIFE	3 SCHOOLS	SCHOOL			200	200
W PERCH		5				5
W BASS	6	4				10
B BULLHEA	2			1		3

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: JUNE 15\87			NS			
SPECIES: SMB		12		6	8	26
GZS		2				2
CARP		20		P		20
WS		30		P		30
ALEWIFE	1000	1000		100		2100
WALLEYE		2				2
W BASS		16				16
W PERCH		16				16
RB		4				4
						0

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: JUNE 18\87					NS	
SPECIES: SMB	4	6		6		16
FWD		4				4
GZS						0
CARP		30	20	8		58
WS		P	10	7		17
ALEWIFE		1000	1000	1000		3000
WALLEYE		3				3
W BASS		16	6			22
W PERCH		16	6			22
B BULLHEAD		P				0
LAMPREY		P				0
Y PERCH				4		4

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: JUNE 22\87						
SPECIES: SMB				22	35	57
FWD					20	20
CARP	3	3	4	37	45	92
WS	2	34	1	13	8	58
ALEWIFE	200	1500	200	1300	50	3250
WALLEYE				11	4	15
W BASS				50	50	100
W PERCH				6		6
B BULLHEAD				300		300
Y PERCH				8		8
CHAN CAT					2	2

APPENDIX 1
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
MARCH 23-JULY 30,1987

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	TOTAL
DATE: JUNE 30\87						
SPECIES: SMB				32	100	132
FWD		6		6	300	312
CARP	24	12	24	12		72
WS	12	5	16	24		57
ALEWIFE	500	3000	1000	1000	2000	7500
WALLEYE		2	2	1	4	9
W BASS	6			100		106
W PERCH				12		12
B BULLHEAD				300		300
A EEL		1			5	6

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE		LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE:	FEB.3,87								
SPECIES:	SMB	10	4		30	6	3	8	61
	FWD		1	5	1				7
	GZS	2	7		30		3	30	72
	CARP	30	38	37	200	50	150	100	605
	WALLEYE							2	2
	W PERCH		1						1
	W BASS		4	1	4		3		12
	COHO				1				1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE		LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE:	FEB.26,87								
SPECIES:	SMB		1	7	14	7	10	2	41
	FWD	6	25	50	45		26	15	167
	GZS		18	45		2	30	23	118
	CARP	50	260	180	30	27	100	25	672
	WALLEYE		1	1					2
	WS		1	4	3		3		11
	W PERCH	1							1
	W BASS		1				3	2	6

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE		LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE:	MAR 16,87								
SPECIES:	SMB	6	4	15	7				32
	FWD	8	50	25	5		2	2	92
	GZS		45	46	20		6	6	123
	CARP	20	65	52	24	3	30	10	204
	WALLEYE		5	5	3		2		15
	A EEL		1						1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAR.23,87								
SPECIES: SMB	28	10	37	25				100
FWD	15	20	11			2	2	50
GZS	4		40	40				84
CARP	23	32	40	21		19	19	154
WALLEYE	2	1	5	16				24
W PERCH	50	250						300

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: APR.13,87								
SPECIES: SMB	3	1		33		10	1	48
FWD		2	16	8		22	12	60
GZS				1		1	2	4
CARP	22	78	22	20	2	99	53	296
WALLEYE			2	2		6		10
WS		2				1	1	4
W BASS		3						3
A EEL							1	1
COHO				1				1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: APR.21,87								
SPECIES: SMB	2	7	10	10		3	1	33
FWD	15	5	20	16		6	6	68
CARP	45	29	62	20	1	43	20	220
WALLEYE	1	1	3	3		1	1	10
WS						1	4	5
RB			1					1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: APR.28,87					NS			
SPECIES: SMB	5	14	11	3		7	3	43
FWD	4	16	10	104		105	50	289
CARP	20	76	146	106		220	72	640
WALLEYE	1		1	1		2		5
WS			18	12		11	9	50
W PERCH			4	2			1	7
Y PERCH							1	1
W BASS				1				1
A EEL		1				1		2
GOLDFISH		1						1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 4,87			NS	NS	NS	NS	NS	
SPECIES: SMB	2							2
FWD	3	5						8
CARP	20	20						40
WALLEYE		1						1
WS		5						5
GOLDFISH	1							1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 5,87					NS	NS	NS	
SPECIES: SMB	1		1	22				24
FWD				4				4
CARP		20	30					50
WS	2	2	2	4				10
RB	1							1
W BASS		1	1					2
B CRAPPIE				1				1
L TROUT		1						1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 6,87	NS	NS	NS		NS	NS	NS	
SPECIES: SMB				10				10
FWD				10				10
GZS				5				5
CARP				50				50
WALLEYE				3				3
WS				20				20
ALEWIFE				50				50

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 7,87					NS	NS	NS	
SPECIES: SMB	1			5				6
FWD	25		100	110				235
CARP	25		100	75				200
WALLEYE	5		6					11
WS		50	20	20				90
W PERCH				12				12
W BASS				4				4
L TROUT				2				2

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 8,87				NS	NS	NS	NS	
SPECIES: SMB	5							5
CARP			50					50
WALLEYE			12					12
WS			20					20

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 25,87					NS	NS		
SPECIES: SMB	4			3				7
FWD	1			15			15	31
CARP	8	10	10	30			20	78
WALLEYE			4					4
WS	4	30	90	35			5	164
COHO								

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 26,87					NS		NS	
SPECIES: SMB	1		1	1		20		23
FWD		17	8	150		15		190
GZS	1					1		2
CARP		45	85	100		100		330
WALLEYE		1	2	8		3		14
WS		65	115	100		30		310
RB						10		10
W BASS				7		4		11
GOLDFISH						2		2

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 27,87	NS	NS	NS	NS			NS	
SPECIES: SMB						12		12
FWD						10		10
CARP					6	60		66
WALLEYE						2		2
WS						25		25
RB						25		25
GOLDFISH						2		2
PUMPKINSEED						1		1
A EEL						1		1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 28,87					NS		NS	
SPECIES: SMB	3		8			13		24
CARP	20	15		6		5		46
WS	18	50				2		70
RB						5		5
W PERCH	1							1
Y PERCH						1		1
W BASS			1					1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: MAY 29,87	NS	NS	NS	NS	NS			
SPECIES: SMB						9	1	10
FWD						50	12	62
CARP						25	1	26
WALLEYE						2		2
WS						25	16	41
Y PERCH						1	2	3
W BASS						6		6
N PIKE							1	1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE 1,87	NS	NS	NS		NS		NS	
SPECIES: SMB				4		14		18
FWD						25		25
GZS						3		3
CARP				30		165		195
WALLEYE				1		8		9
WS				100		60		160
W BASS				4				4

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE 3,87								
SPECIES: SMB			8	4		7		19
FWD			P			15	5	20
CARP	20			30		80	20	150
WALLEYE						1		1
WS	10			30		20	10	70
ALEWIFE		100						100
W PERCH						4		4
Y PERCH						2		2
L TROUT		1						1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE 5,87	NS	NS	NS	NS	NS			
SPECIES: SMB						10	7	17
FWD						50	20	70
CARP						50	20	70
WALLEYE						1		1
WS						56	20	76
RB						3		3
Y PERCH							4	4
A EEL							20	20

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE 8,87	NS	NS	NS	NS	NS			
SPECIES: SMB						19	5	24
CARP						4	6	10
WS						3	6	9
RB						4		4
A EEL						8	3	11
GOLDFISH						1		1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE12,87	NS	NS	NS	NS	NS			
SPECIES: SMB						16	3	19
WS						20	30	50
RB						4	10	14
Y PERCH							2	2
A EEL							2	2

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE 15,87							NS	
SPECIES: SMB		1		1	1	10		13
FWD	4		5					9
CARP	30		20					50
WALLEYE			10			1		11
WS	50	15	40					105
ALEWIFE		1000			100			1100

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE17,87	NS	NS	NS	NS			NS	
SPECIES: SMB						4		4
CARP						100		100
WALLEYE						2		2
WS						100		100
ALEWIFE					1000			1000
A EEL						1		1

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE18.87	NS	NS	NS	NS	NS			
SPECIES: SMB						7	2	9
CARP							20	20
RB						3		3
ALEWIFE							100	100

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JUNE29,87	NS	NS	NS	NS	NS		NS	
SPECIES: SMB						24		24

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JULY 22,87							NS	
SPECIES: SMB	30	4	2	6	8	11		61
FWD	3		6			30		39
CARP	15	24	24		1	99		163
WALLEYE	9	6	8					23
ALEWIFE	1000	100			200			1300
W PERCH						54		54
WB			1		1	16		18
A EEL	8	6				1		15

APPENDIX 2
LOCATION OF FISH SPECIES OBSERVED WITHIN PICKERING A DISCHARGE CHANNEL
FEB.3,87-JULY 30,87

PK A DISCHARGE	LOC.1	LOC.2	LOC.3	LOC.4	LOC.5	LOC.6	LOC.7	TOTAL
DATE: JULY30,87	NS	NS	NS	NS			NS	
SPECIES: SMB	3		1	2	2	4	1	13
FWD	24		6	6		8	4	48
CARP	30	50	15	15	3	200	100	413
WALLEYE	1							1
RB						1		1
ALEWIFE			1000	1000				2000
W PERCH	30							30
WB	30						60	90

APPENDIX 3

SPECIES PRESENT DURING 1987 SURVEYS

APPENDIX C
ZONE 1 - PICKERING A DISCHARGE

	SME	FWD	GIS	CARP	WALLEYE	WS	RB	CC	ALE	WP	WB	LP	AEEL	YP
JULY 30				X	X	X			X					
JULY 22				X		X			X					
JUNE 18														
JUNE 15	INS													
JUNE 8	INS													
JUNE 3	INS													
JUNE 1	X						X							
MAY 29	INS													
MAY 22	INS													
MAY 27	INS													
MAY 26	INS													
MAY 25	INS													
MAY 8	INS													
MAY 7	INS													
APR 30		X		X		X			X					
APR 24		X		X		X	X		X	X	X			
APR 13	INS													
MAR 23	INS													

APPENDIX 3 (CONT'D)
ZONE 2 - PICKERING A DISCHARGE

		SMB	FWD	GZS	CARP	WALLEYE	WS	RB	CC	ALE	WP	WB	LP	AEEL	YP
JULY 30					X	X	X			X				X	
JULY 22					X		X			X					
JUNE 18		X	X		X	X	X			X	X	X			
JUNE 15		X		X	X	X	X	X		X	X	X			
JUNE 5		X			X		X			X	X	X			
JUNE 3		NS													
JUNE 1		NS													
MAY 29		NS													
MAY 28					X		X								
MAY 27		NS													
MAY 26		NS													
MAY 25		NS													
MAY 8		NS													
MAY 7		NS													
APR 30		X	X	X	X	X	X			X		X	X		
APR 24			X		X	X	X			X	X	X	X		
APR 13		X			X		X								
MAR 23		X			X										

SPECIES

APPENDIX 3 (CONT'D)
ZONE 3 - PICKERING A DISCHARGE

	SMB	FWD	GIS	CARP	WALLEYE	WS	RB	CC	ALE	WP	WB	LP	AEEL	YP
JULY 30				X	X	X			X					
JULY 22				X		X			X					
JUNE 18														
JUNE 15	NS													
JUNE 5	NS													
JUNE 3	NS													
JUNE 1	X						X							
MAY 29	NS													
MAY 28	NS													
MAY 27	NS													
MAY 26	NS													
MAY 25	NS													
MAY 8	NS													
MAY 7	NS													
APR 30		X		X		X			X					
APR 24		X		X		X	X		X	X	X			
APR 13	NS													
MAR 23	NS													

APPENDIX 3 (CONT D)
ZONE 4 - PICKERING A DISCHARGE

JULY 30	X			X	X	X			X	X				
JULY 22	X			X	X	X			X	X	X			X
JUNE 18	X			X		X			X					X
JUNE 15	X			X		X			X					
JUNE 5	X					X	X							X
JUNE 3	X			X		X	X							X
JUNE 1	X			X	X	X				X				X
MAY 29	X	X		X		X								X
MAY 28	NS													
MAY 27						X								X
MAY 26											X			X
MAY 25	X		X		X	X	X		X		X			X
MAY 8														
MAY 7			X	X		X								X
APR 30		X	X	X	X	X			X	X	X			X
APR 24						X			X					
APR 13	X	X	X	X	X		X							
MAR 23	X	X	X	X										
	SMB	FWD	GZS	CARP	WALLEYE	WS	RB	CC	ALE	WP	WB	LP	AEEL	YP

SPECIES

APPENDIX 3 (CONT'D)
ZONE 5 - PICKERING A DISCHARGE

	SMB	FWD	GIS	CARP	WALLEYE	WS	RB	CC	ALE	WP	WB	LP	AEEL	YP
JULY 30	X	X			X				X		X		X	
JULY 22	X	X		X	X	X		X	X		X			
JUNE 18	NS													
JUNE 15	X													
JUNE 5	X					X			X					
JUNE 3				X										
JUNE 1	X			X	X	X	X		X				X	X
MAY 29	X		X	X	X	X			X					
MAY 28	X	X	X	X	X	X	X				X		X	X
MAY 27	X			X		X							X	X
MAY 26	X			X	X	X								
MAY 25	X			X		X			X		X			
MAY 8	NS													
MAY 7	X			X		X	X							
APR 30		X	X	X	X	X			X	X	X	X	X	
APR 24	X	X		X	X	X			X		X		X	
APR 13			X	X	X	X								
MAR 23	NS													

SPECIES

APPENDIX 3 (CONT'D)
ZONE 1 - PICKERING B DISCHARGE

		SMB	FWD	GZS	CARP	WALLEYE	WS	RB	ALE	WP	WB	AEEL	GOLDF	BB
JULY 31	X		X		X					X	X			
JULY 22	X		X		X				X			X		
JUNE 29	NS													
JUNE 19	NS													
JUNE 17	NS													
JUNE 15	X		X			X								
JUNE 12	NS													
JUNE 8	NS													
JUNE 5	NS													
JUNE 3	X		X			X								
JUNE 1	NS													
MAY 29	NS													
MAY 28	X		X			X				X				
MAY 27	NS													
MAY 26	X			X				X						
MAY 25	X		X			X								
MAY 8	X		X			X								
MAY 7	X	X	X		X									
MAY 6	NS													
MAY 5	X					X		X						
MAY 4	X	X	X										X	
APR 28	X	X	X		X									
APR 21	X	X	X		X									
APR 13	X		X											
MAR 23	X	X	X		X									
MAR 16	X	X	X											
FEB 26		X	X							X				
FEB 3	X			X	X									

SPECIES

APPENDIX 3 (CONT'D)
ZONE 2 - PICKERING B DISCHARGE

JULY 30				X										
JULY 22	X			X	X									
JUNE 29	NS						X							
JUNE 18	NS													
JUNE 17	NS													
JUNE 15	X					X	X							
JUNE 12	NS													
JUNE 8	NS													
JUNE 5	NS													
JUNE 3							X						X	
JUNE 1	NS													
MAY 29	NS													
MAY 28				X		X								
MAY 27	NS													
MAY 26		X		X	X	X								
MAY 25				X		X								
MAY 8														
MAY 7						X								
MAY 6	NS												X	
MAY 5				X		X								
MAY 4		X		X	X	X					X	X		
APR 28	X	X		X										
APR 21	X	X		X	X					X				
APR 13	X	X		X		X			X					
MAR 23		X		X	X						X			
MAR 16	X	X	X	X	X					X				
FEB 26	X	X	X	X	X	X			X	X				
FEB 3	X	X	X	X										

	SMB	FWD	GIS	CARP	WALLEYE	WS	RB	ALE	WP	WB	AEEL	GOLDF	BB	LT

SPECIES

APPENDIX 3 (CONT'D)
ZONE 3 - PICKERING & DISCHARGE

		SMB	FHD	GZS	CARP	WALLEYE	WS	RB	LE	WP	WB	AEEL	GOLDF	BB	LT
JULY 30	X				X				X						
JULY 22	X				X	X					X				
JUNE 29	NS														
JUNE 19	NS														
JUNE 17	NS														
JUNE 15					X	X	X								
JUNE 12	NS														
JUNE 8	NS														
JUNE 5	NS														
JUNE 3	X														
JUNE 1	NS														
MAY 29	NS														
MAY 28											X				
MAY 27	NS														
MAY 26	X	X			X	X	X								
MAY 25					X	X	X								
MAY 8					X	X	X								
MAY 7		X			X	X	X								
MAY 6	NS														
MAY 5	X				X		X				X				
MAY 4	NS														
APR 28	X	X			X	X	X			X					
APR 21	X	X			X	X		X							
APR 13		X			X	X									
MAR 23	X	X	X		X	X									
MAR 16	X	X	X		X	X									
FEB 26	X	X	X		X	X	X								
FEB 3		X			X						X				

SPECIES

APPENDIX 3 (CONT'D)
ZONE 4 - PICKERING B DISCHARGE

		SMB	FWD	GZS	CARP	WALLEYE	WS	RB	ALE	WP	WB	AEEL	GOLDF	LT	B. CRAPPIE	COHO
JULY 30	X		X		X				X							
JULY 22	X															
JUNE 29	NS															
JUNE 18	NS															
JUNE 17	NS															
JUNE 15	X															
JUNE 12	NS															
JUNE 8	NS															
JUNE 5	NS															
JUNE 3	X				X		X									
JUNE 1	X				X	X	X				X					
MAY 29	NS															
MAY 28	X				X											
MAY 27	NS															
MAY 26	X	X			X	X	X				X					
MAY 25	NS					X	X									
MAY 8	NS															
MAY 7	X	X			X		X			X	X			X		
MAY 6	X	X		X	X	X	X		X							
MAY 5	X	X					X								X	
MAY 4	NS															
APR 28	X	X			X	X	X			X	X					
APR 21	X	X			X	X										
APR 13	X	X		X	X	X										
MAR 23	X			X	X	X										
MAR 16	X	X		X	X	X										
FEB 26	X	X			X		X									X
FEB 3	X	X		X	X						X					

SPECIES

APPENDIX 3 (CONT'D)
ZONE 5 - PICKERING B DISCHARGE

JULY 30	X			X									
JULY 22	X			X				X		X			
JUNE 29	NS												
JUNE 18	NS							X					
JUNE 17								X					
JUNE 15	X												
JUNE 12	NS												
JUNE 8	NS												
JUNE 5	NS												
JUNE 3													
JUNE 1	NS												
MAY 29	NS												
MAY 28	NS												
MAY 27				X									
MAY 26	NS												
MAY 25	NS												
MAY 8	NS												
MAY 7	NS												
MAY 6	NS												
MAY 5	NS												
MAY 4	NS												
APR 28	NS												
APR 21				X									
APR 13				X									
MAR 23													
MAR 16				X									
FEB 26	X		X	X									
FEB 3	X			X									

SMB	FWD	GZS	CARP	WALLEYE	WS	RB	ALE	WP	WB	AEEL	GOLDF	LT	COHO

SPECIES

APPENDIX 3 (CONT'D)
ZONE 6 - PICKERING B DISCHARGE

		SMB	FWD	GZS	CARP	WALLEYE	WS	RB	ALE	WP	WB	REEL	GOLDF	YP	COHO	PUMPKINSEED
JULY 30	X				X			X								
JULY 22	X		X		X					X	X	X				
JUNE 29	X							X								
JUNE 18	X															
JUNE 17	X				X	X	X					X				
JUNE 15	X					X										
JUNE 12	X						X	X								
JUNE 8	X				X		X	X				X	X			
JUNE 5	X		X		X	X	X	X								
JUNE 3	X		X		X	X	X			X				X		
JUNE 1	X		X	X	X	X	X									
MAY 29	X		X		X	X	X				X			X		
MAY 28	X				X		X	X						X		
MAY 27	X		X		X	X	X	X				X	X			X
MAY 26	X		X	X	X	X	X	X			X		X			
MAY 25	NS															
MAY 8	NS															
MAY 7	NS															
MAY 6	NS															
MAY 5	NS															
MAY 4	NS															
APR 28	X		X		X	X	X					X				
APR 21	X		X		X	X	X									
APR 13	X		X	X	X	X	X									
MAR 23			X		X											
MAR 16			X	X	X	X										
FEB 26	X		X	X	X		X				X					
FEB 3	X			X	X						X					

SPECIES

APPENDIX 3 (CONT'D)
ZONE 7 - PICKERING B DISCHARGE

		SMB	FWD	GZS	CARP	WALLEYE	WS	RB	ALE	WP	WB	AEEL	GOLDF	YP	NORTHERN PIKE
JULY 30	X		X		X						X				
JULY 22	NS														
JUNE 29	NS														
JUNE 19	X				X				X						
JUNE 17	NS														
JUNE 15	NS														
JUNE 12	X						X	X				X		X	
JUNE 8	X				X		X					X			
JUNE 5	X		X		X		X					X		X	
JUNE 3			X				X	X							
JUNE 1	NS														
MAY 29	X		X		X		X							X	X
MAY 28	NS														
MAY 27	NS														
MAY 26	NS														
MAY 25			X		X		X								
MAY 8	NS														
MAY 7	NS														
MAY 6	NS														
MAY 5	NS														
MAY 4	NS														
APR 28	X		X		X		X			X				X	
APR 21	X		X		X	X	X								
APR 13	X		X	X	X		X					X			
MAR 23			X		X										
MAR 16			X	X	X										
FEB 26	X		X	X	X						X				
FEB 3	X			X	X	X									

SPECIES